

Fraction Practice

Lesson time: 25-45 Minutes



Lesson Overview

Students will explore the nature of fractions through playing the game: Refraction. They will practice decomposing fractions by partitioning them and in some cases will compose new fractions by composition. Some puzzles will require persistence and high levels of problem solving as the students may need to try several different strategies to create the correct fraction, find their way around obstacles, and orient the benders to send their lasers in the correct direction.

Lesson Objectives

Students will:

- Practice persistence and problem-solving
- Create equivalent fractions by partitioning and re-combining fractions
- Discover the results of splitting a value into two and three parts
- Discover the results of chaining together success splits
- Discover the results of combining (adding) a fraction with like bases

Anchor Standard

Common Core Math Standards

4.NF.3a	Understand addition and subtraction of fractions as joining and separating parts referring to the same whole.
4.NF.3b	Decompose a fraction into a sum of fractions with the same denominator in more than one way, recording each decomposition by an equation. Justify decompositions, e.g., by using a visual fraction model.

Lesson Plan Summary

- **Introduction (1-5 minutes)**
- **Game Play (15-25 minutes)**
- **Reflection (10-15 minutes)**

Materials, Resources, and Prep

For the Student

- At least one computer for every two students
- Any handouts desired for the reflection activity

For the Teacher

- Ensure you can load the game from your classroom:
http://play.centerforgamescience.org/refraction_remix/cgs/ Note that there are 4 versions of refraction on our website. This is the “Remix” version.
- Decide if, and how, you want to activate prior knowledge before the game
- Decide how the vocabulary will be incorporated into the lesson
- Prepare at least one reflective activity for the class

Lesson Plan Details

Vocabulary

This lesson has a number of words that can be incorporated. These should not necessarily be introduced at the beginning but the teacher should try to use as many as appropriate and assess understanding of the chosen words upon completion:

- **Fraction:** A number which represents equal parts of a whole.
- **Rotation:** A rotation is also known as a turn. For a bender, this will change its direction by a quarter turn BUT WILL not change its left or right quality.
- **Reflection:** A reflection is also known as a flip. For a bender that is sending laser to the right, a reflection will send the laser to the left. This also works for up and down.
- **Equivalent Fraction:** A fraction is equivalent when the numbers are different but they represent the same quantity of parts to the whole. For instance, $\frac{1}{2}$ of cake is equivalent to $\frac{2}{4}$ of a cake. While not exactly the same, splitting a laser can be thought of as creating an equivalent fraction. Partitioning $\frac{1}{2}$ into 3 parts create 3 lasers worth $\frac{1}{6}$, so the analogy is that $\frac{1}{2}$ is an equivalent fraction to $(\frac{1}{6} + \frac{1}{6} + \frac{1}{6})$ or $\frac{3}{6}$.

Introduction

Students will come into this lesson with varying experience of fractions. In general, less talk at the start is better but activating some prior knowledge (especially student-to-student) may be helpful. Here are a few questions that might be worth discussing before (and definitely after) some game play.

hard. Maybe a student can't solve it but they can describe some strategies they might try to begin to solve it.

Reflection & Wrap-up

Research has shown **critical** that some form of debriefing takes place after any game in the class room for the learning benefits to be realized. Reflection is where the students transfer the play into learning outcomes. Based on your adaptation of this lesson, please choose **at least one** to implement in the classroom.

- Discuss (or re-discuss) any of the pre-game questions
- Provide a screen-shot of a level (real or one you make up). Have the students model the answer by creating a drawing, a paragraph, or an equation to describe the solution. Compare the different representations.
- Live action Post-game Game! Set up a grid and make certain students right and left benders. Make others 2 and 3-way splitters. Make one student a source and one a target. One student is the player. Everyone else can be a "direct laser connector". It starts by the source repeating their value: "1...1...1". If a splitter is set up in front of them, the splitter puts out his/her arms and says "1/2...1/2...1/2". If a connector is put in front of them they continue to repeat "1/2...1/2...". This will likely get a little loud which is part of the fun. The game ends when the correct fraction reaches the target.
- Practice making equivalent fractions with this tool. Have them write down 5 sets of 3 equivalent fractions. <http://illuminations.nctm.org/Activity.aspx?id=3510>
- Make number strips folded into halves, thirds, fourths, fifths, sixths, ninths, and tenths. Have them mark where equivalent fractions occur.
- Provide (or have them make) a set of fraction cards. Have them place them on a number line and include equivalent fractions together at the same spot.
- Practice partitioning fractions.
<http://www.commoncoresheets.com/Math/Fractions/Dividing%20Unit%20Fractions%20Visual/English/1.pdf>
- Practice identifying equivalent fractions visually:
<http://www.commoncoresheets.com/Math/Fractions/Finding%20Equivalent%20Fractions%20-%20Visual%20M/English/1.pdf>

END OF LESSON PLAN. MATERIAL BELOW THIS POINT FOR REFERENCE ONLY. NO NEED TO PRINT (OR READ UNLESS CURIOUS).

Additional Common Core Math Standards which are connected to this lesson

3.NF.1	Understand a fraction $\frac{1}{b}$ as the quantity formed by 1 part when a whole is partitioned into b equal parts; understand a fraction $\frac{a}{b}$ as the quantity formed by a parts of size $\frac{1}{b}$.
4.NF.1	Explain why a fraction $\frac{a}{b}$ is equivalent to a fraction $\frac{n \times a}{n \times b}$ by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions.
4.NF.3a	Understand addition and subtraction of fractions as joining and separating parts referring to the same whole.
4.NF.3b	Decompose a fraction into a sum of fractions with the same denominator in more than one way, recording each decomposition by an equation. Justify decompositions, e.g., by using a visual fraction model.
4.NF.3c	Add and subtract mixed numbers with like denominators, e.g., by replacing each mixed number with an equivalent fraction, and/or by using properties of operations and the relationship between addition and subtraction.
4.NF.3d	Solve word problems involving addition and subtraction of fractions referring to the same whole and having like denominators, e.g., by using visual fraction models and equations to represent the problem.
5.NF.7a	Interpret division of a unit fraction by a non-zero whole number, and compute such quotients.

GAME AND PROGRESSION NOTES:

GOALS STUDENTS SHOULD HAVE:

- 1) To be able to get the laser to the source. Don't worry about the fraction, just get the laser to the source.
- 2) Experiment with splitting and notice what happens to the lasers. Can they determine a number pattern that matches the laser splitting pattern?
- 3) (For World 5 onward) Look at the denominator of the target. For each of the sources, what is the equivalent fraction with that denominator? Not sure? start splitting! For instance, if the source is $\frac{1}{2}$ and the target is $\frac{5}{6}$ they should figure out that $\frac{1}{2}$ is $\frac{3}{6}$ (or 3 sets of $\frac{1}{6}$ if they use the splitter to discover this)

A brief outline of the levels and their contents is below.

Refraction has 7 worlds with 7 to 10 levels each.

1 World 1 introduces the game. All the numbers are whole number.

1-1 Using benders. The benders will automatically orient to receive the laser.

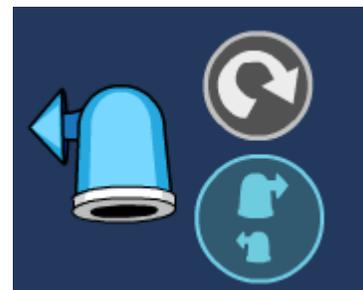
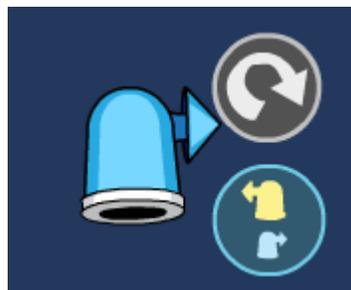
1-2 Using multiple benders to go around a corner.

1-3 Using multiple benders.

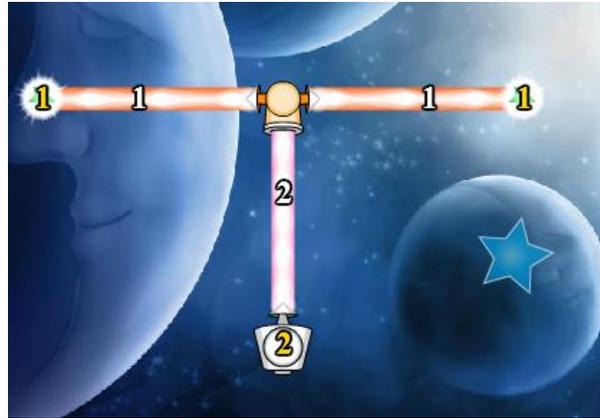
1-4 If a bender does not orient correctly, it can be rotated.



1-5 If a bender does not orient correctly, it can be reflected.



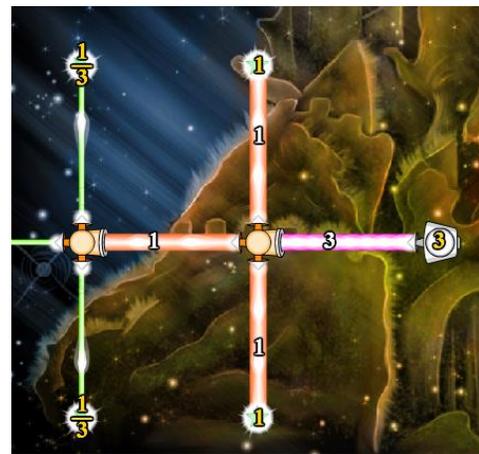
1-6 A splitter breaks a value into two equal parts.



1-7 Splitting into three equal parts.

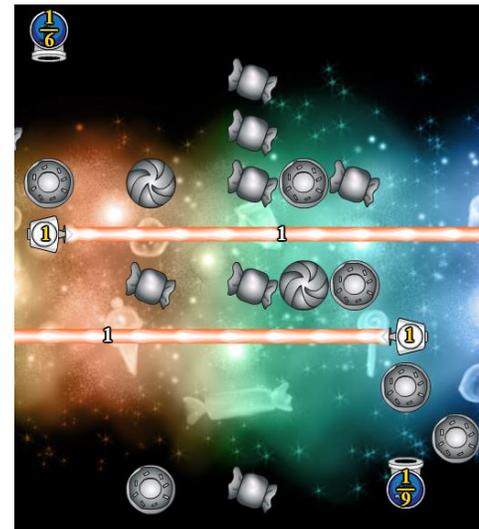
2 World 2: Some of the spaceships need fraction power

- 2-1 Use two splitter to break 2 into 1 and $\frac{1}{2}$
- 2-2 Use multiple splitters to break 3 into 1,1, $\frac{1}{3}$ and $\frac{1}{3}$
- 2-3 Use Splitter and Bender to morph 3 into $\frac{1}{3}$
- 2-4 Use splitters to break 1 into $\frac{1}{2}$ and $\frac{1}{4}$
- 2-5 1 to $\frac{1}{9}$, $\frac{1}{9}$, and $\frac{1}{3}$
- 2-6 1 to $\frac{1}{6}$ and $\frac{1}{3}$
- 2-7 1 to $\frac{1}{3}$ and $\frac{1}{6}$



3 World 3: More practice

- 3-1 1 to $\frac{1}{4}$, $\frac{1}{4}$, $\frac{1}{4}$, and $\frac{1}{4}$
- 3-2 1 to $\frac{1}{9}$, $\frac{1}{9}$, $\frac{1}{9}$, and $\frac{1}{9}$
- 3-3 1 to $\frac{1}{9}$ and $\frac{1}{6}$
- 3-4 1 to $\frac{1}{9}$, $\frac{1}{9}$, $\frac{1}{6}$, and $\frac{1}{6}$
- 3-5 2 sources. 1 and 1. Must produce $\frac{1}{6}$ and $\frac{1}{9}$. →
- 3-6 1 to $\frac{1}{8}$
- 3-7 1 to $\frac{1}{12}$
- 3-8 1 to $\frac{1}{8}$ and $\frac{1}{12}$
- 3-9 1 to $\frac{1}{9}$ and $\frac{1}{12}$



4 World 4: Multiple Sources

- 4-1 Sources: $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{7}$. Targets: $\frac{1}{7}$, $\frac{1}{5}$ (only benders needed)
- 4-2 Sources: $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$. Targets: $\frac{1}{8}$, $\frac{1}{9}$, $\frac{1}{4}$
- 4-3 Sources: 1, $\frac{1}{2}$. Targets: $\frac{1}{9}$, $\frac{1}{6}$
- 4-4 Sources: $\frac{1}{2}$. Targets: $\frac{1}{12}$, $\frac{1}{8}$
- 4-5 Sources: $\frac{1}{3}$, $\frac{1}{2}$. Targets: $\frac{1}{12}$, $\frac{1}{18}$
- 4-6 Sources: $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$. Targets: $\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{10}$
- 4-7 Sources: $\frac{1}{3}$, $\frac{1}{4}$. Targets: $\frac{1}{12}$, $\frac{1}{24}$

4-8 Sources: $1/6$, $1/7$. Targets: $1/14$, $1/24$

5 World 5: Introduction of Combiners

5-1 Sources: 1 , $1/2$, $1/2$. Target: 2

5-2 Sources: $1/2$, $1/2$. Target: $1 \rightarrow$

5-3 Sources: $1/4$, $1/4$, $1/4$. Target: $3/4$

5-4 Sources: $1/2$, $1/4$. Target: $3/4$

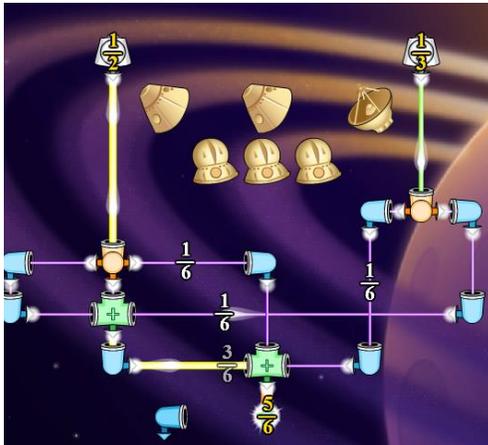
5-5 Sources: $1/2$, $1/3$. Target: $5/6$

5-6 Sources: $1/2$, $1/4$, $1/8$. Target: $7/8$

5-7 Source: 1 . Target: $2/3$

5-8 Sources: $1/3$, $1/3$, $1/3$. Target: $7/9$

5-9 Sources: $1/2$, $1/3$. Target: $5/12$



One example 5-5: $1/2 + 1/3 = 5/6$. You can combine them directly (boring!) or show how $1/2$ can be split into three $1/6$'s, how $1/3$ can be split in to two $1/6$'s, and then how they can all be combined back together as $5/6$. Way more creative and fun!!

6 Targets may have more than one laser port, Introduction of Improper Fractions

6-1 Sources: $1/2$, $1/2$. Target: 1

6-2 Sources: $1/2$, $1/3$. Target: $5/6$

6-3 Source: 1 . Targets: $1/2$, $1/3$

6-4 Sources: 1 , $1/2$, $1/4$. Targets: $2/3$, $3/4$

6-5 Sources: 1 , 1 . Target: $4/3$

6-6 Sources: $1, 1, 1$. Target: $5/2$

6-7 Sources: $1, 1, 1$. Targets: $5/4$, $3/2$

6-8 Sources: $1/2$, $1/2$, $1/3$, $1/3$. Target: $7/6$

6-9 Sources: $1/2$, $1/2$, $1/4$, $1/8$. Target: $11/8$

6-10 Sources: 1 , $2/3$, $3/5$. Target: $11/10$

7 More Practice. Must split and recombine

7-1 Sources: $1/2$, $1/2$. Target: $1/3$

7-2 Sources: $1/2$, $1/2$. Targets: $1/3$, $2/3$

7-3 Sources: 1 , ½. Target: ¾
7-4 Sources: ¼, ¼, ¼. Targets: 3/8, 3/16
7-5 Sources: ½ , ½, 3/8. Targets: 9/8, 5/8
7-6 Sources: 1, 1/3, 1/3, 1/3. Targets: 11/9, 5/9
7-7 Sources: 1/3, 1/3, 3/5. Target: 16/15
7-8 Sources: 1/3 , 1/4. Target: 7/24
7-9 Sources: 1 , ½. Targets: 7/12, 11/24

MORE NOTES ABOUT THE PROGRESSION:

All students should play all the levels in World 1 to familiarize themselves with the game, benders, and splitters.

Based on your lesson plan as well as the individual students' background and experience, you may give students the choice to start somewhere in the middle. If they have not played Refraction before, they **should play World 1 before skipping ahead.**

MORE IDEAS ON CLASSROOM MONITORING:

It is **possible for students to skip levels or accidentally repeat the same level** over and over again. When monitoring students look for the following:

- Are they struggling to get the laser to get to the target? If so, having them return to the very early levels OR having another student explain about rotating and reflecting the benders would be worthwhile.
- Are they hitting the target but with an incorrect fraction? Once again, consider sending them back to some earlier levels AND having them explain how to make 1 become 1/3. If they understand this, they may simply be struggling with the fraction. Good advice (although not always the quickest solution) is to break all of the sources into the same denominator as the target. For instance, if the target is 5/6, break all the sources into sixths. From here the student can count how many beams make up 1/6. A key point here (especially if combiners have not been introduced) is that ½ is the same as 3/6. You could break them into sixths and re-combine but you don't need to.
- Are they super-frustrated with the level? Have them skip it or have them help someone else (doing something else for a few minutes may give them fresh eyes when they come back). OR have them try 4 different ways – don't worry if they are right, just make sure each one is different (they'll likely find the solution through this experimentation).
- If students seem very far behind, it may be they continue to repeat the same level. They may be hitting the Stay on This Level button at the lower right instead of the Next Level! button just below it.
- If the main menu makes it appear that **they have solved far more levels than you think possible**, it's likely a cache issue. The cache is the memory that the browser keeps for the game. If another player from a previous class has been playing on the same computer, it may be that the computer is remembering this first player's history. You can simply ignore it, open an anonymous version of the browser (which will not have a cache and all stars from completed levels will be removed), or clear the cache (this process will vary by browser).